REGAN

Tests of Railroad Tie Plates

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TESTS OF RAILROAD TIE PLATES

BY

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

RALPH HOWARD REGAN

ENTITLED TESTS OF RAILROAD TIE PLATES

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Mechanical Engineering

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TESTS OF RAILROAD TIE PLATES

I. INTRODUCTION.

With the rapidly decreasing supply of hard wood, necessitating the use of soft wood for railroad ties, the ever increasing speeds at which trains are being run, and the great weights of rolling stock now in use on our railroads, the use of tie plates to protect ties from undue wear by the pounding action of the rails and to hold rails to gage has become very common. There are three distinct types of tie plates made: (1) the longitudinal flange plates with one or more projecting flanges which are forced into the tie and which extend along the grain; (2) the transverse claw plates having projecting claws which are driven into the tie and which cut across the grain; and (3) the flat plates with neither projecting claws nor flanges. The various companies manufacturing tie plates have from time to time conducted tests, comparing their plates with those of other makers. Little has been done, however, in the line of tests by disinterested parties.

A series of tests to determine some relative properties of various types of plates has been planned, to be carried on in the Laboratory of Applied Mechanics at the University of Illinois. The tests of which this thesis is a report, resolved themselves into a preliminary series to determine proper methods of conducting tie plate tests. Some of our tests as carried on by tie plate makers were modified at Illinois to make the test conditions more nearly represent actual practice. Lack of time alone prevented the carrying on of a more extensive series of tests. However, data were obtained which give results of some value. The writer wishes to express his thanks for the hearty co-operation received from the following persons, firms, and corporations:

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The Lake Shore and Michigan Southern R. R.

Mr. George F. Boyd, Roadmaster
The Illinois Central Railroad

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The Central Railroad of New Jersey

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Chicago, Milwaukee & St. Paul Railroad

Mr. A. F. Robinson, Bridge Engineer
Atchison, Topeka and Santa Fe Railroad

Mr. A. L. Kuehn, Engineer of Track and Roadway
Cleveland, Cincinnati, Chicago and
St. Louis Railway

Mr. J. B. Berry, Chief Engineer
Chicago, Rock Island and Pacific Railway

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The Railroad Supply Company, Chicago

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Theoretical and Applied Mechanics
University of Illinois

Mr. E. C. Carter, Chief Engineer
Chicago & Northern Railway Co.

Mr. J. M. Egan, Road Master
Illinois Central Railroad

Mr. W. D. Taylor, Chief Engineer
Chicago and Alton Railroad

II. MATERIALS AND TESTS.

Materials.- Owing to the short time available in this year's tests only red oak ties treated with creosote were used. This wood, creosoted, is in very common use for ties on the Peoria and Eastern division of the C. C. C. & St. L..Ry., from whom all the ties for these tests were obtained, and in their practice red oak ties are usually creosoted and fitted with tie plates even when laid in a tangent. In all cases sixty-five pound rails with corresponding plates were used.

The materials used were furnished gratuitously as follows: Ties by the Cleveland, Cincinnati, Chicago, and St. Louis Railroad Company; Wolhaupter and flat plates by the Railroad Supply Company, Chicago, Illinois; Goldie, Glendon, Dilworth, and flat plates by Messrs. Dilworth, Porter and Company, Pittsburg, Pennsylvania. Many other other plates were furnished but shortness of time compelled us to choose a limited number for these tests and the above named plates were chosen as being typical of flange, flat, claw, and shoulder plates. Drawings of plates used in these tests are submitted.

Tests.- The experiments undertaken were (1) An investigation of the resistance to buckling with embedment; (2) The determination of the resistance to lateral thrust.

(1) Buckling Test with Embedment. The buckling test was first tried with supports about seven inches apart under the plates and the force applied on the top of a rail set in position on the plate. This test was found to be unfair to

some plates as their design was such that they would buckle very quickly when not supported at all points, as is the case when the plate is in position in the tie. The test did not give a fair indication of the useful properties of the plates in service. Results of such a test would be useful only when comparing plates of the same type.

It was found that the buckling and embedment tests could be carried on at the same time. For this purpose a Riehle 100,000-lb. testing machine having an autographic device for recording the pressure and embedment was used. (See Fig. 2) Ames test gages by which deflections of .0001 of an inch could be measured were then attached as shown in Fig. 3. The machine was run at a speed of 1/10-inch per minute. At every five thousand pounds increase in load the machine was stopped and readings taken of the deflection on each test gage. Thus the autographic attachment to the machine gave a record of the amount the plate was forced into the tie (neglecting the compression of parts of machine and of the tie which would be practically the same for all plates) while from the readings of the four test gages the buckling of the plate could be determined. Increments of pressure were added until the rail was flush with the tie. As far as possible each kind of plate used was forced into each tie used so that errors due to condition of ties were minimized. No plate was forced into the tie nearer than six inches to the end.

(2) Resistance to Lateral Thrust. To get results of resistance to lateral thrust which would be indicative of the relative merits of the various plates, it was found necessary to apply two loads, one vertically to hold the plates to the tie; the other a lateral horizontal force tending to slide the plate out of gage. To get the first force, a Philadelphia 100,000-lb. testing machine was used. Two iron beams A (see Fig. 3) were designed to transmit this force to the plates. The plates were placed on the ties in pairs, properly embedded, and rails spiked through them, using one spike outside of the rail and two inside. The iron beams were forced by the testing machine against the rails with a force of 40,000 pounds, and this pressure was maintained throughout the test. The beams were beveled at the ends to an angle of fifteen degrees with the horizontal in order to overcome the friction between the rails and the beam due to the sliding of the plate. (See Fig. 3). It was found by experiments that 15° was the angle of repose of a steel plate sliding over the edge of a rail. The lateral pressure was obtained by means of a hydraulic jack B, (Fig. 3) operated by hand and the amount of pressure was read on a gage. As these tests are relative tests, and as the hydraulic jack was placed in the same position for every lateral sliding test, the error due to friction of jack would be very nearly the same for all tests and has not been determined. The jack lay between the two iron beams A. At first the force of the jack was transmitted to the rail through the rail head as this is the way it is accomplished

in actual practice. Ames dial test gages C giving readings of .0001 inch were placed in contact with each plate so as to show the amount of lateral slide of each plate over the tie. The force was applied with the jack and as the plates slid the vertical load was kept constant by the testing machine. This test was seen to resolve itself into a spike pulling test as the inside spikes pulled before the plates slid. The jack was then lowered so as to exert its pressure as near the bottom of the web as possible, (see Fig. 3). In this way the plates were caused to slip along the tie as the pressure increased.

Readings of the test gages showed the amount of sliding of plate over tie as before.

III. EXPERIMENTAL DATA AND DISCUSSION.

Resistance to Buckling with Embedment.- Table 1 shows a sample set of readings made in a test of a Wolhaupter plate. The complete field notes of all tests made for this thesis may be found in the log book of the thesis which is on file in the Research office of the Laboratory of Applied Mechanics. The curves in Fig. 10 were made by striking an average of the curves of each plate as made by the autographic device. The curves of Fig. 11 show the greatest average buckling of each type of plate when forced into the tie. Table 2 compares the buckling of plates at 50,000 lb. load. It is seen that the flange plates offer the greatest resistance to buckling. The proportional buckling between the four plates tested seems to have remained nearly the same as the load increased. It seems strange that the flat plate should offer practically the same resistance to buckling as the Goldie. It was thought that the claws on the Goldie would help to resist the buckling force; this did not seem to be the case. Table 3 shows the amount of embedment at 50,000 lb. load. Zero embedment marks normal position of plate in tie. Here again the flange plate gives evidence of superiority, lending credence to the claim of flange plate makers that the flanges tend to compress the wood in such a manner as to make it resist the indentation of the plate more strongly. The plain rail offered

the least resistance to embedment. The base of the rail cut the fibers of the wood and thus let the rail sink in, while in the case of the tie plate the plates bent or buckled so that no sharp edges came in contact with the tie, thus there was no cutting of the fibers. This is largely responsible for the resistance of the ties with plates to deep indentation. Some such reason must exist since the area under the plate as compared with that of ties with rail alone was very nearly the same.

Resistance to Lateral Thrust.- Table 4 is a sample set of data taken in a test of a Wolhaupter plate. Curves in Fig. 12 show the average slip of each plate for the various loads. From these it is noticed that the flat plate holds the rail fairly well up to a lateral thrust of 20,000 lb. when the plate begins to slide very rapidly over the tie. Up to a lateral thrust of about 28,000 lb. the flange plates seem to hold the rail a little better than the claw. At higher loads the claw plate appears to offer the greatest resistance to lateral sliding. The flange slides at some definite constant pressure; its amount of slip depending upon the speed with which the force is applied.

The adhesion of plate to tie is considered of some importance as giving some index of the tendency of any particular plate to become practically a fixed part of its tie, in which case any motion of the track takes place between the rail and

the plate, the spikes loosening or wearing the small fraction of an inch necessary to allow this motion. We then have steel rail wearing on steel tie plate, and not rail and tie plate wearing on the tie. No quantitative measurements of adhesion of plate to tie were made in these tests, but on removing plates from tie it was evident that flange plates offered much less resistance to withdrawal than claw plates. Of course, flat plates offered no resistance at all to removel from tie.

IV. CONCLUSIONS.

From these tests it is very evident that tie plates do exert a great influence in preventing spreading of track, holding the track to gage, and preventing the rail from entering the ties. It appears that with new ties of rather hard wood the claw plate exerts the most influence in preventing spreading of the track under heavy lateral loads. Under light lateral loads, however, there is little difference between the performances of the different types. The flange plate appears to offer the most resistance to indenting the tie and to buckling. The flat plate is useful in holding the rail to gage in that it makes all the spikes exert a resisting force against spreading the rail. This force, however, is less for flat than for either claw or flange plates. Flat plates have no adhesion to the tie, while longitudinal flange plates have less than claw plates.

No attempt has been made to determine the effect of weather or traffic on the different types of plates. This appears to be a very important line of testing. This and other tests will undoubtedly be carried on in the future by the Engineering Experiment Station of the University of Illinois.

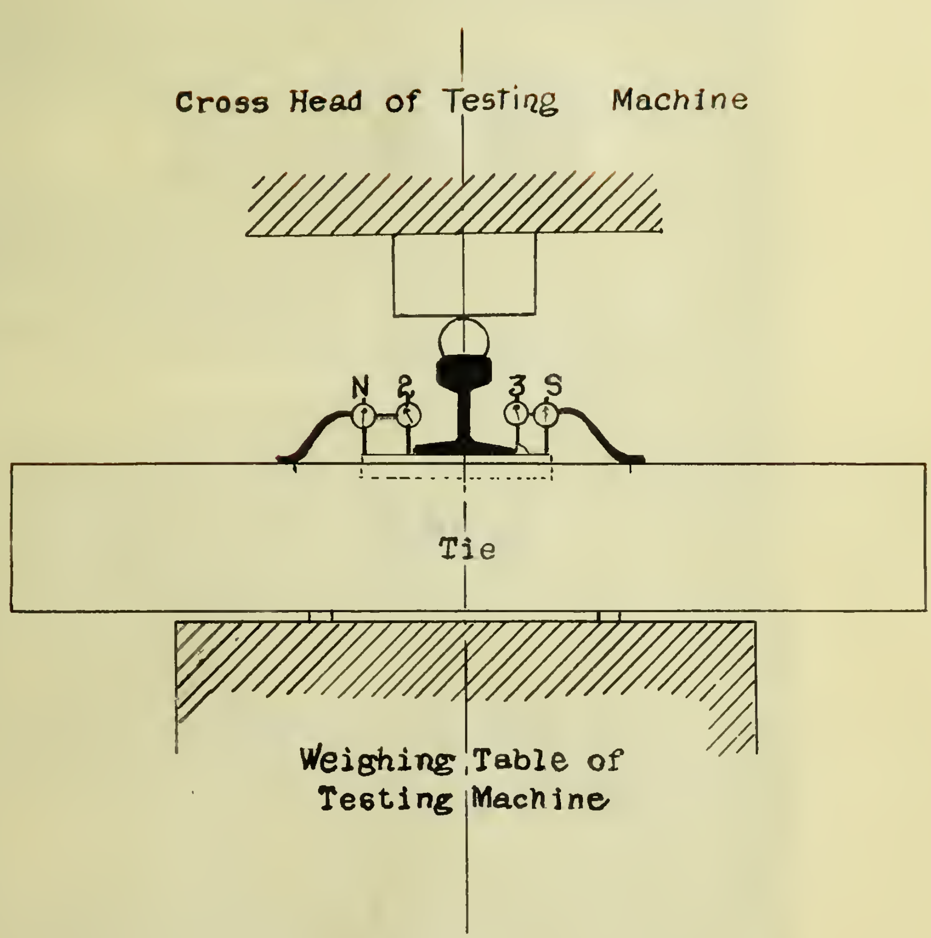


Figure 1.

Diagram of Apparatus for

Test of Resistance to Buckling and Embedment.

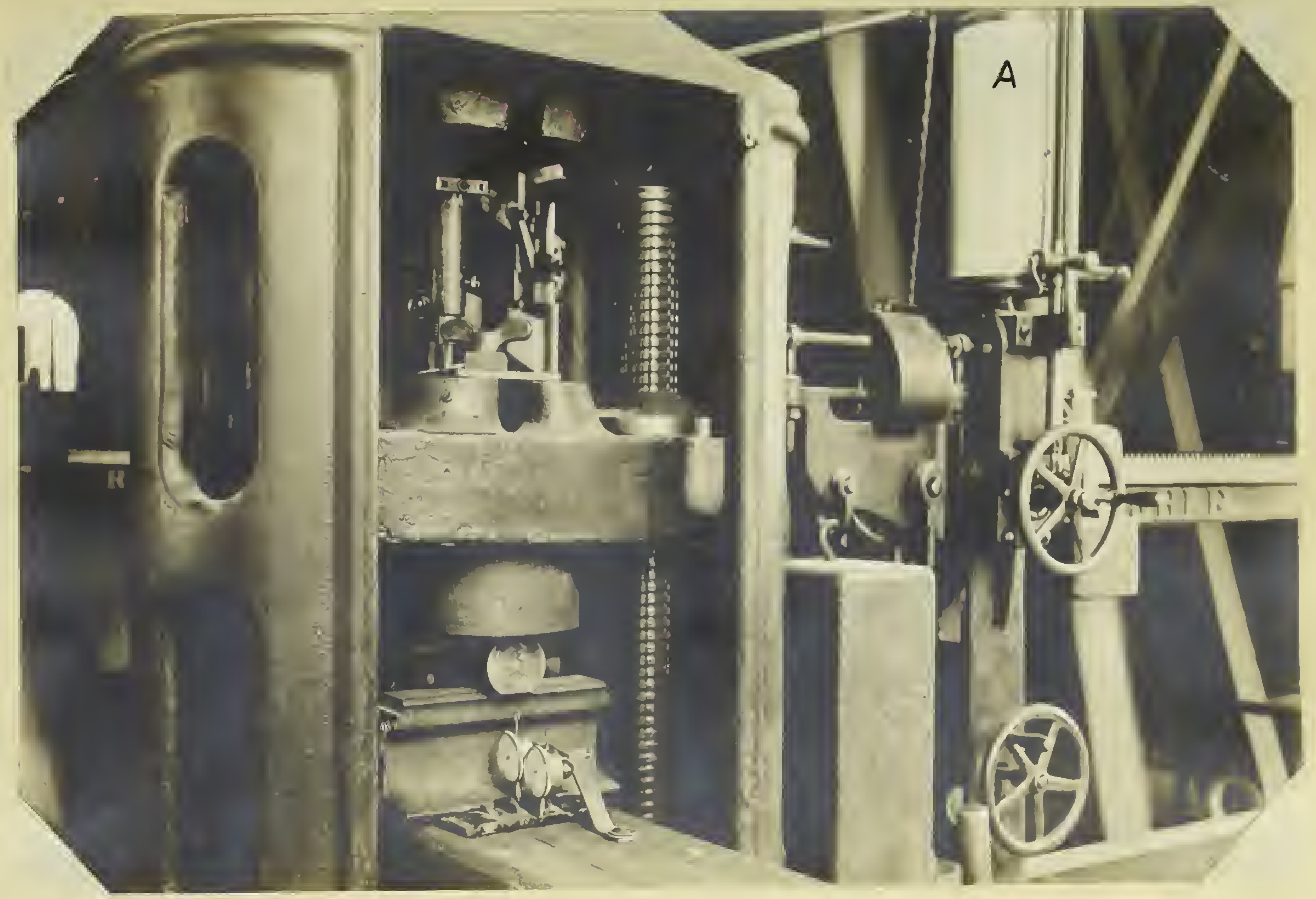


Figure 2.

Riehle Machine Rigged for Buckling and Embedment Test.

A Cylinder of Autographic Recording Device.

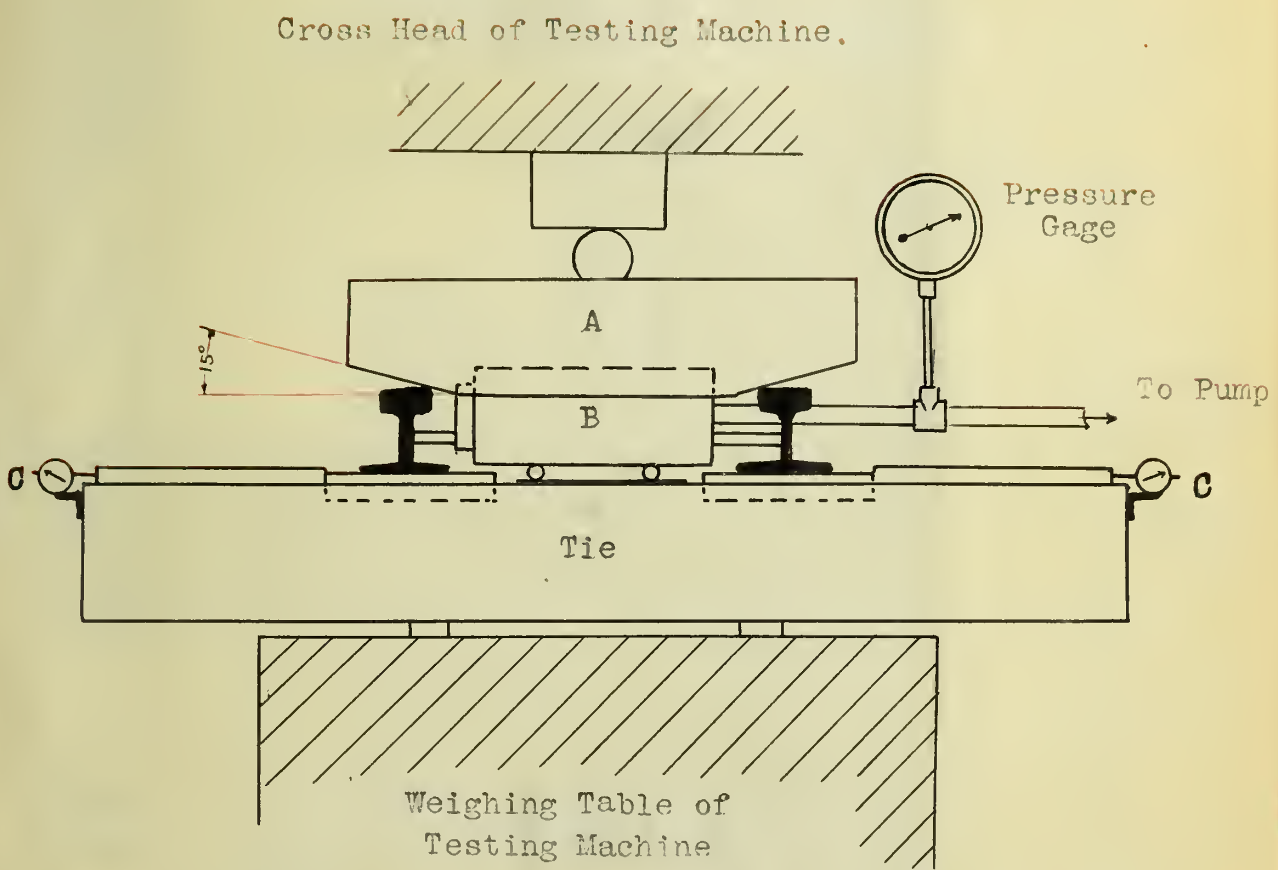


Figure 3.

Diagram for Test of Resistance to Lateral Motion.

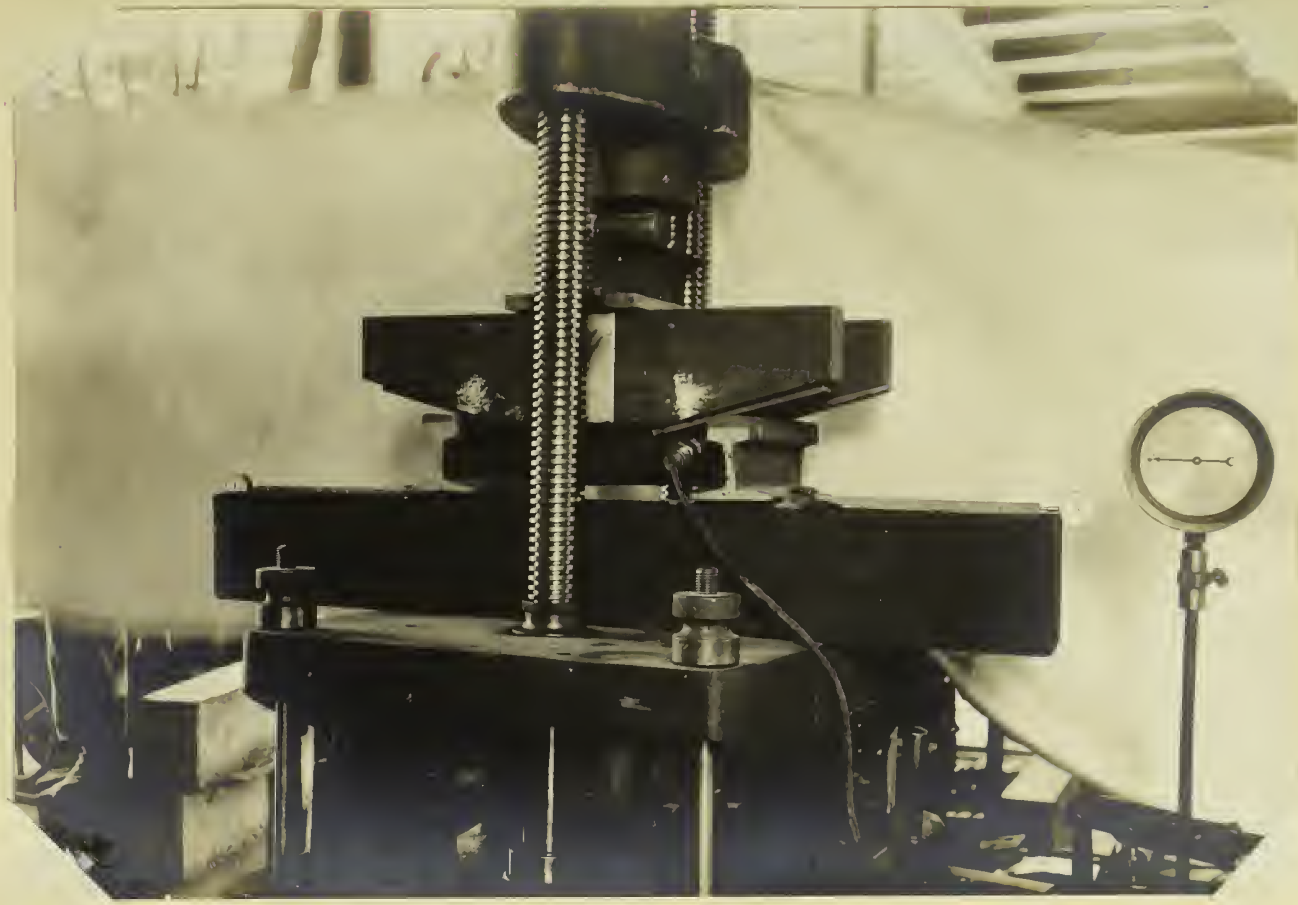


Figure 4.

Philadelphia Machine Rigged for Test of Resistance to Lateral Motion

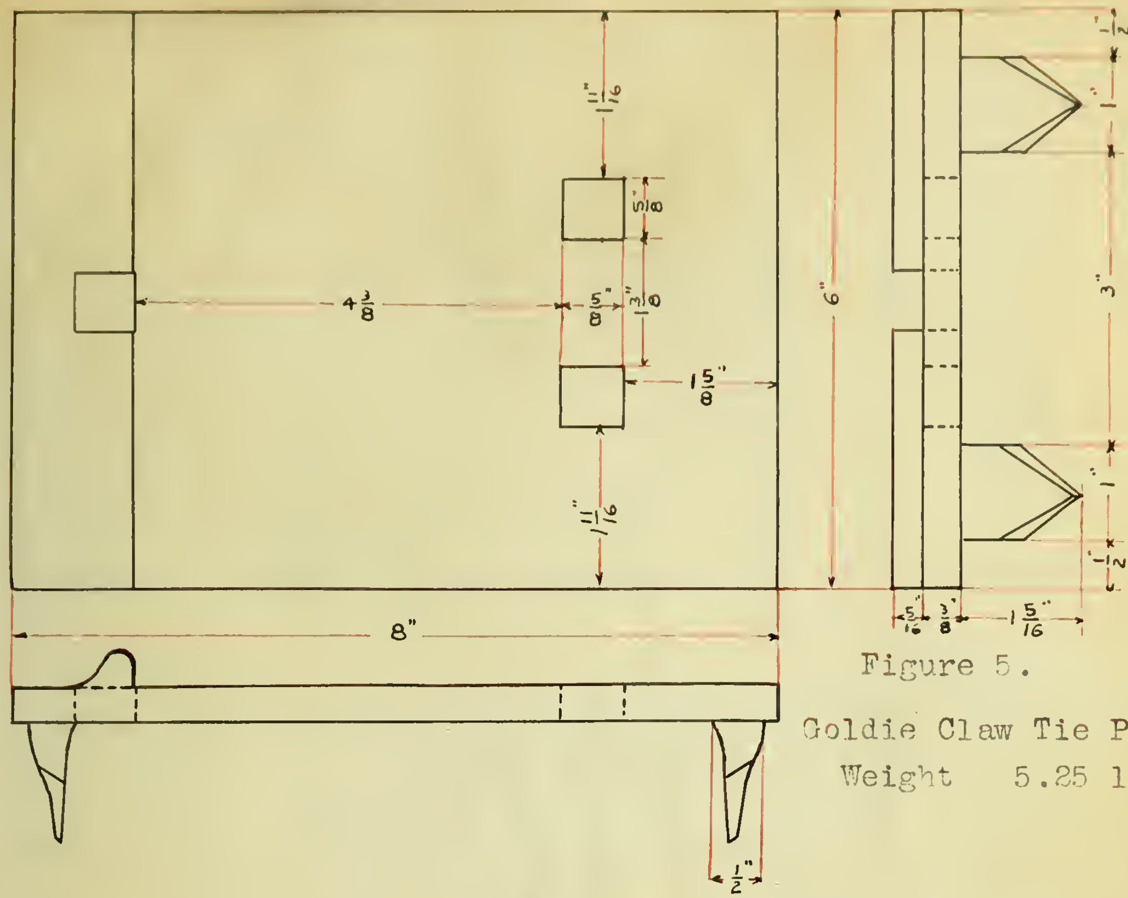


Figure 5.
Goldie Claw Tie Plate
Weight 5.25 lb.

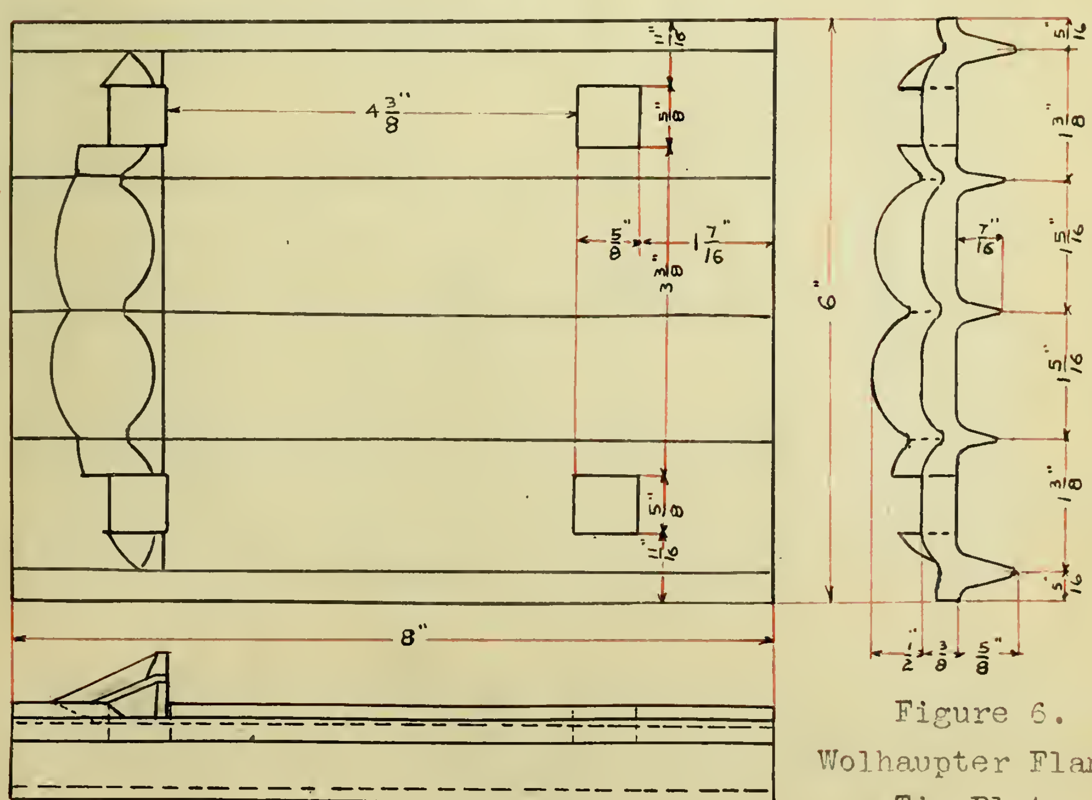


Figure 6.
Wolhaupter Flange
Tie Plate
Weight 5.7 lb.

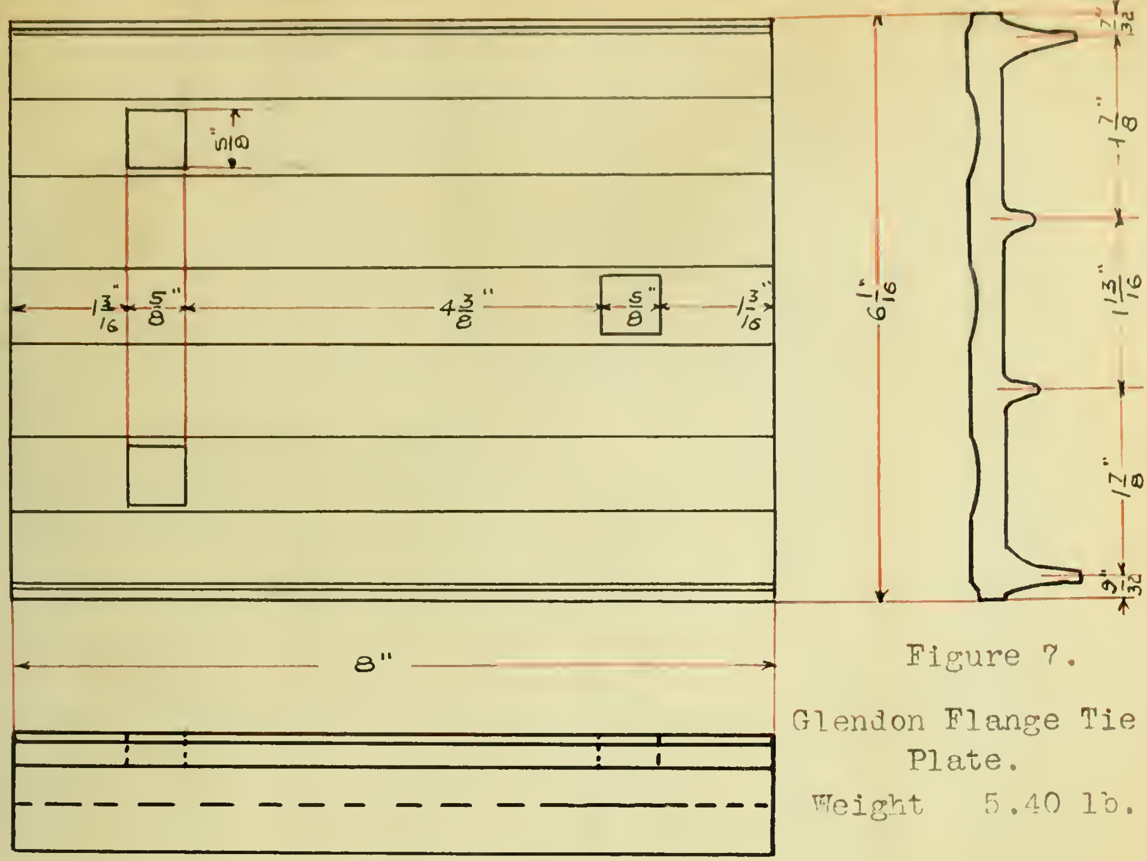


Figure 7.

Glendon Flange Tie Plate.

Weight 5.40 lb.

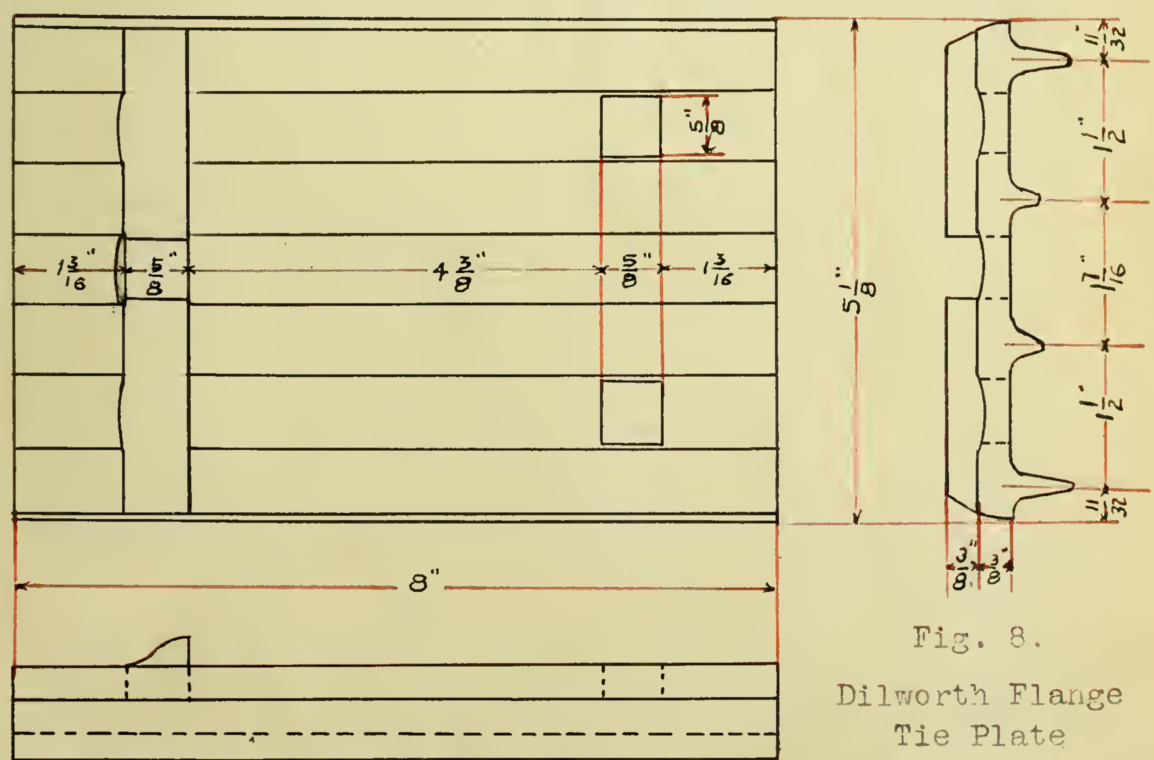


Fig. 8.

Dilworth Flange Tie Plate

Weight 4.7 lb.

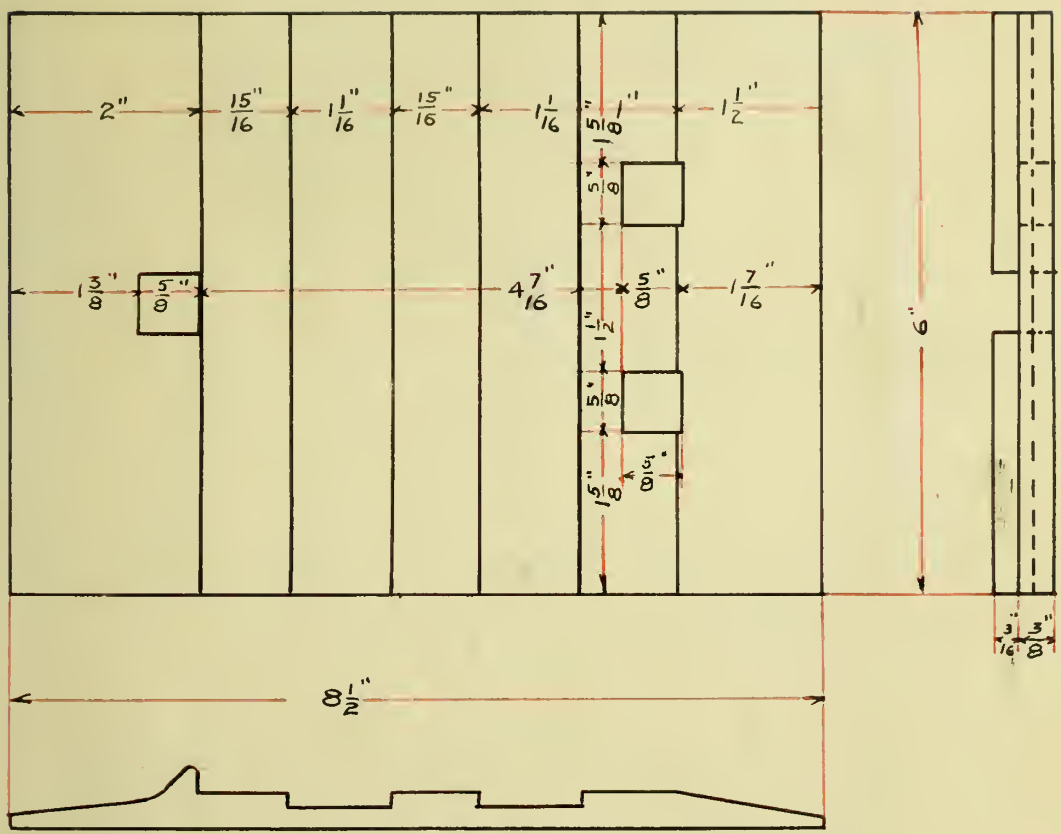


Figure 9.

Flat Tie Plate

Weight 4.00 lb.

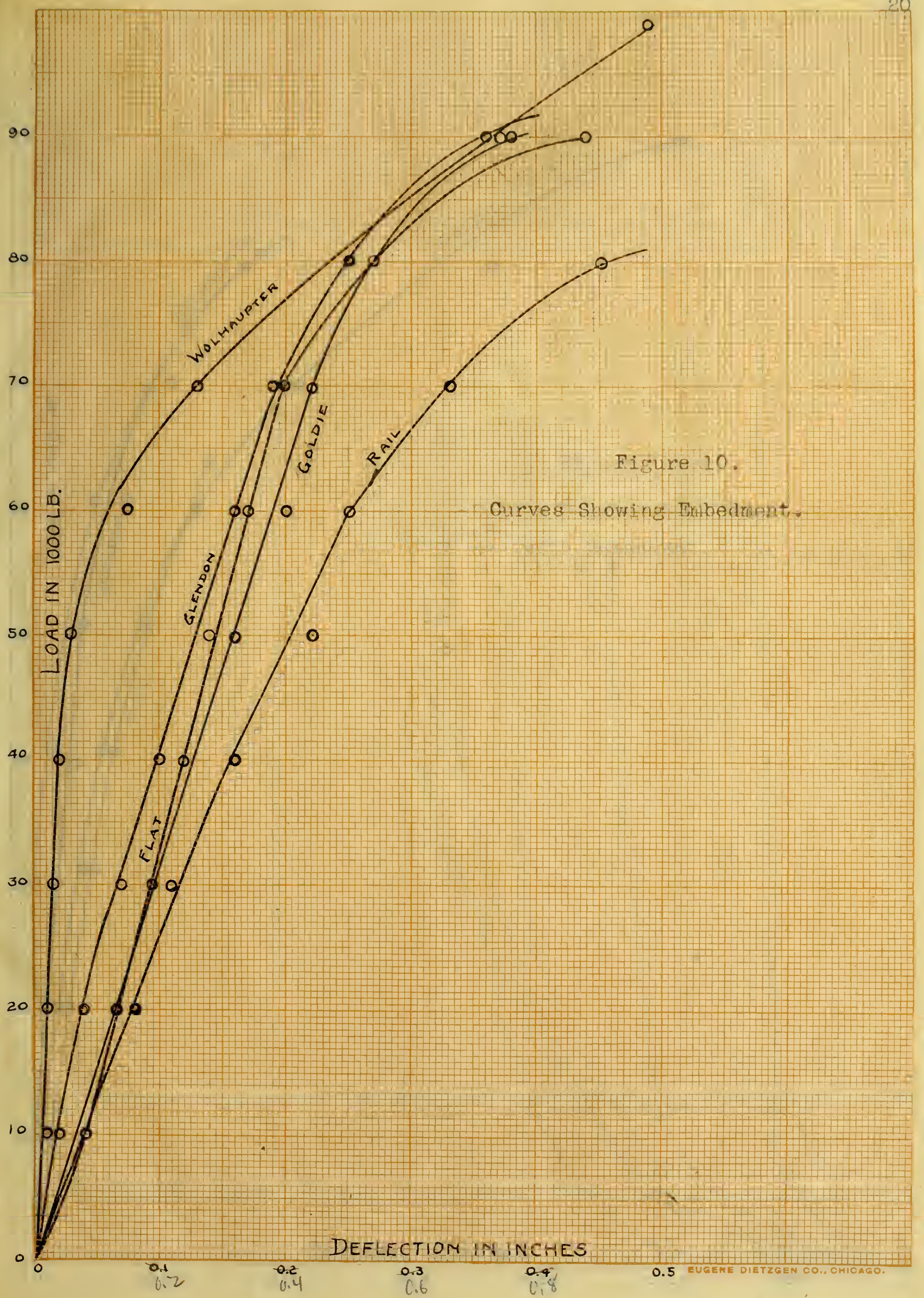
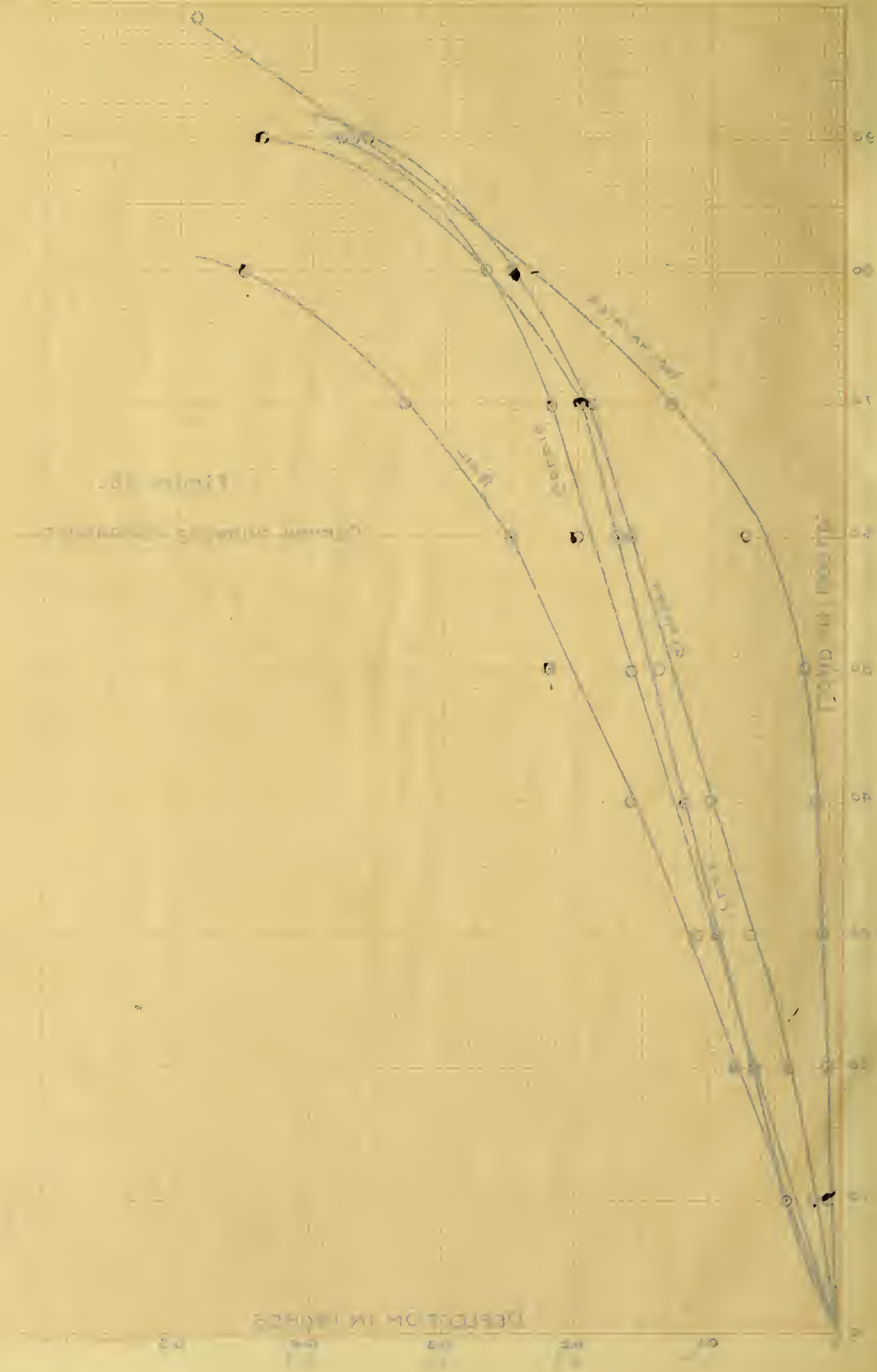


Figure 10.
Curves Showing Embedment.
LOAD IN 1000 LB.
DEFLECTION IN INCHES
WOLHAUPTER
GOLDIE
RAIL
GLENDON
FLAT
0
10
20
30
40
50
60
70
80
90
0.1
0.2
0.3
0.4
0.5
0.2
0.4
0.6
0.8
EUGENE DIETZGEN CO., CHICAGO.



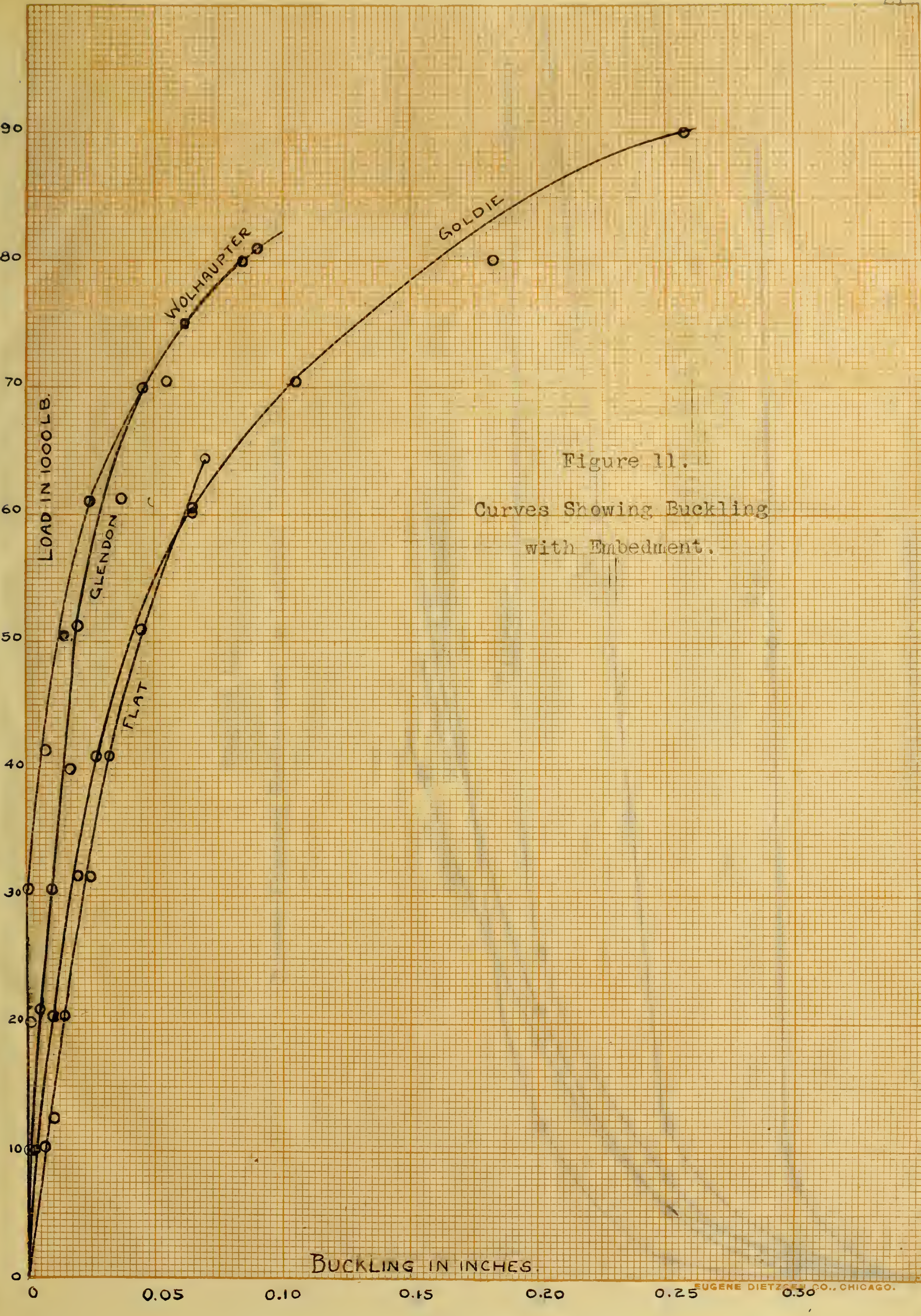


Figure 11.

Curves Showing Buckling with Embedment.

Figure 12.

Curves Showing Resistance to Lateral Thrust.

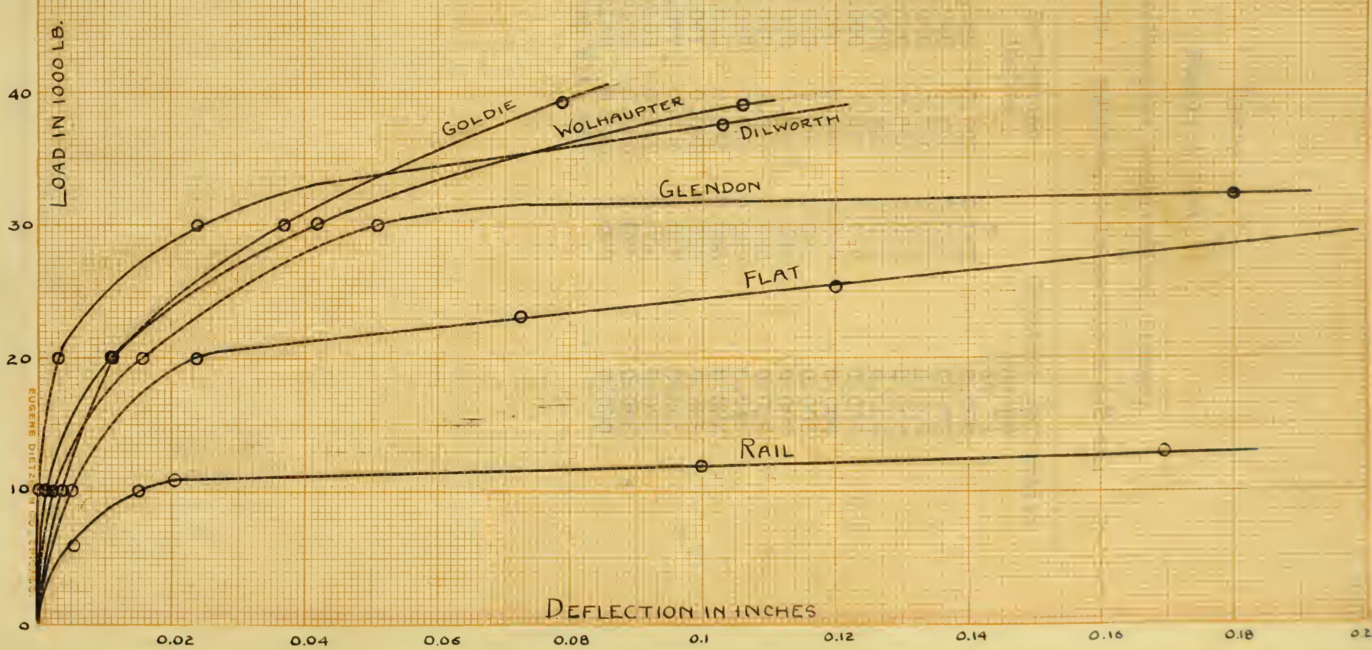


Table 1.

Buckling Test.

Plate, Wolhaupter Longitudinal Flange,

6 x 8 x 3/8-in., punched, 4 holes 5/8 x 5/8-in.

Load lb.	Deflection inches				Greatest Deflection inches
	N	2	3	S	(at 2)
1 000	0.000	0.000	0.000	0.000	0.000
5 700	0.000	0.000	0.005	0.002	0.000
10 000	0.000	0.000	0.010	0.005	0.000
15 200	0.000	0.000	0.016	0.008	0.000
20 200	0.000	0.000	0.025	0.013	0.000
25 400	0.000	0.000	0.033	0.017	0.000
31 100	0.004	0.005	0.038	0.019	0.000
35 900	0.009	0.013	0.043	0.021	0.003
41 100	0.014	0.020	0.049	0.023	0.008
46 100	0.018	0.027	0.054	0.026	0.010
50 200	0.024	0.037	0.062	0.029	0.015
55 400	0.031	0.049	0.071	0.034	0.023
60 400	0.036	0.061	0.083	0.039	0.038
65 500		0.077	0.095	0.047	0.043
70 100	0.047	0.103	0.118	0.062	0.055
75 300	0.060	0.129	0.138	0.075	0.065
80 300	0.069	0.162	0.164	0.090	0.090
95 000	Rail flush with tie.				

Table 2.

Buckling Test (with embedment)

Load 50 000 pounds.

Plate	Size in.	Deflection in.
Wolhaupter	6 x 8 x 3/8	.015
Glendon	6 x 8 x 3/8	.019
Goldie	6 x 8 x 3/8	.040
Flat	6 x 8 1/2 x 3/8	.044

Table 3.

Embedment Test

Load 50 000 pounds

Plate	Size in.	Indentation in.
Wolhaupter	6 x 8 x 3/8	.03
Glendon	6 1/16 x 8 x 3/8	.13
Flat	6 x 8 1/2 x 3/8	.14
Goldie	6 x 8 x 3/8	.16
Rail		.25

Table 4

Resistance to Lateral Motion

Plate, Wolhaupter Longitudinal Flange 6 x 8 x 3/8-in.

Lateral Motion pounds	Vertical Motion pounds	Deflection inches
0	40 000	0.000
10 000	40 000	0.000
20 000	40 000	0.007
30 000	40 000	0.077
39 000	40 000	0.083
41 500	40 000	0.110

Lateral Load of 30 000 lb. held constant for three minutes. Increase of slip .04 inch.

At 41 500 lb. deflection increased indefinitely as load was kept up.